



## News

### Reagan's Budget Slashes Geophysics R&D

When President Ronald Reagan outlined a joint session of Congress his proposed revisions to the Carter fiscal 1982 budget (*Eos*, February 10, p. 49), Congress responded with 13 bursts of applause and one standing ovation. Geophysicists, however, may not greet the budget pruning with equal fanfare. Reagan's across-the-board cuts include proposals for slashing research and development funds. Among those hardest hit are NASA, NOAA, and NSF.

The preliminary Reagan budget document, *America's New Beginning: A Program for Economic Recovery*, outlines the proposed cuts, but dollar-by-dollar analyses have yet to be posted. Details of funding for individual programs will be released next week with the publication of the complete budget. *Eos* will monitor those changes that will affect geophysicists.

Despite the enthusiasm shown by Congress during Reagan's February 18 speech, the acid test of Capitol Hill opinion on the revised budget will come when work begins on budget approval. According to a report in the *Washington Post* on the morning following the speech, Reagan aides believe that chances for approval are best if the budget is considered quickly and as a total package.

### NASA's GRO and VOIR Deferred

Jimmy Carter allocated a 21% increase over the fiscal 1981 budget for NASA in fiscal 1982. This sharp increase is incompatible with a program of across-the-board restraint, Reagan reasoned. He therefore proposes to whittle the increase to about 12%, giving the agency real growth of 2% with a 10% inflation rate. NASA is now budgeted for \$6.235 billion in fiscal 1982, a decrease of \$330 million from the Carter budget.

The space shuttle program probably will be maintained, but the Gamma Ray Observatory, the Vanu Orbital Imaging Radar, and the Spacelab experiments will be deferred for an unspecified period, according to the Reagan budget document. A NASA scientist said that VOIR will not be deferred but will continue as an item in the budget, however, development will be slower than envisioned by Carter. Full support will continue for the development of the space telescope at the Johns Hopkins University (*Eos*, February 10, p. 50). Funding for the solar electric propulsion system will be eliminated, and space science flight projects will be rescheduled.

Support is provided in Reagan's budget to 'fully utilize spacecraft launched in prior years that are still transmitting useful data.' Voyager spacecraft fall into this category. The

Galileo mission to Jupiter will be maintained as part of an orderly progression in the exploration of the planets. United States participation in the International Solar Polar Mission will continue, but more slowly than Carter had envisioned.

Funds for remote sensing will be cut, as will those for research on weather and climate and those for research on the advanced communications technology needed to increase the useful range of radio frequencies.

### NSF Lab Modernization Postponed

Reagan plans to 'selectively reduce or eliminate' some NSF programs, but he will maintain 'ongoing support for its critical responsibilities in the advancement of science.' Proposed for reduction or elimination are programs deemed of 'less immediate priority' or 'less critical to meeting the goals and objectives' of NSF.

Slated for deferment are all new programs proposed in the Carter 1982 budget for NSF, including the \$75-million program to modernize university laboratories and the program to build the 25-m, millimeter wave telescope in Hawaii. Funds allocated by Carter for basic and applied research in the division of astronomical, atmospheric, earth, and ocean sciences will be maintained, however.

No mention was made of the ocean margin drilling programs. Exact funding for specific programs will be announced next week.

### NOAA Closely Shaved

Government funds for NOAA will be reduced from Carter's \$164 million allocation for fiscal 1982 to \$32 million. Money for the Coastal Energy Impact Program and the Coastal Zone Management Program will be terminated under Reagan's Economic Recovery Program. Federal assistance to sea grant colleges for marine research will be halved. In addition, the National Oceanic Satellite System (NOSS) will be deferred.

'States and localities should assume responsibility for those NOAA programs from which they directly benefit,' Reagan said. He estimated that NOAA program costs can be reduced by more than \$1 billion over the next 5 years. 'These changes are consistent with the original intent of the coastal programs—to provide Federal assistance only when essential and for front-end seed money,' he continued.

Most of the \$1 billion reduction of federal funds can be attributed to the deferment of NOSS. Reagan estimated that the government will save \$900 million over the next 7 years with the postponement. Reagan explained the rationale for the delay: 'The cost of NOSS is too high at this time and oceanographic data needs can be met through other means.'

### USGS Cuts Not Outlined

Reductions, if any, in the USGS fiscal 1982 budget were not delineated in the Reagan preliminary document. Cutbacks for the Department of the Interior were included, but department officials have yet to hammer out the agency breakdowns.—BTS

### Quake Station in China

The United States installed the first permanent seismological station in the People's Republic of China late last year. Located in the city of Kunming, in southern China, the station is part of the International Deployment of Accelerometers (IDA) program, a network of 17 seismometers in 15 countries.

The monitoring equipment, installed by scientists from the University of California's Institute of Geophysics and Planetary Physics at Scripps Institution of Oceanography, measures long-period earth movements that result from major earthquakes. Information collected by cassette recording tape is analyzed by computers in San Diego and is combined with data from other stations worldwide.

### The Petroleum Exponential (Again)

The U.S. production and reserves of liquid and gaseous petroleum have declined since 1960, at least in the lower 48 states. This decline stems from decreased discovery rates, as predicted by M. King Hubbert in the mid-1950's. Hubbert's once unpopular views were based on statistical analysis of the production history of the petroleum industry, and now, even with inclusion of the stalled perturbation caused by the Prudhoe Bay-North Alaskan Slope discovery (the largest oil field ever found in the United States), it seems clear again that production is following the exponential curve to depletion of the resource—to the end of the ultimate yield of petroleum from wells in the United States.

In a recent report, C. Hall and C. Cleveland of Cornell University show that large atypical discoveries, such as the Prudhoe Bay find, are but minor influences on what now appears to be the crucial intersection of two exponential curves (*Science*, 211, 578-579, 1981): the production-per-drilled-foot curve of Hubbert, which crosses zero production no later than the year 2005; the other, a curve that plots the energy cost of drilling and extraction with time; that is, the cost-lime rate of how much oil is used to drill and extract oil from the ground. The intersection, if no other discoveries as large as the Prudhoe Bay field are made, could be as early as 1990, the end of the present decade. The inclusion of each Prudhoe-Bay-size find extends the year of intersection by only about 8 years. Beyond that point, more than one barrel of petroleum would be expended for each barrel

## Forum

### Source of Digital Terrain Data

The digital terrain map of the United States published in the cover of *Eos*, v. 62, no. 1, January 6, 1981, has a number of enquiries about enlarged copies and the source. The terrain data are available from:

U.S. Department of Commerce  
NOAA/EDIS/NGSDC (D62)  
325 Broadway  
Boulder, CO 80303

A color terrain map by R. H. Godson of the U.S. Geological Survey, at an approximate scale of 1:7,500,000, is available as *Miscellaneous Investigations Map I-1312* (available release in late spring). Godson should have been listed as a co-contributor of the image used by *Eos*.

Martin F. J.  
U.S. Geological Survey

extracted from the ground. The oil exploration-extraction and refining industry is currently the second most energy intensive industry in the U.S., and the message seems clear. Either more efficient drilling and production techniques are discovered, or domestic production will cease well before the end of this century if the Hubbert analysis modified by Hall and Cleveland is correct.

A closer look at the method by which the projected intersection of exponentiality was deduced reveals that the actual exponential fit to the 'barrels per foot drilled' production curve, Hubbert's extrapolation was formulated from petroleum industry trends dating back to the 1930's. Then, some 250 barrels of oil were recovered per foot, compared with about 8-25 barrels per foot today. It should also be noted that most domestic oil being produced today comes from fields that were discovered before 1940. In 1977, it cost 1 quantity of energy equivalent to approximately 1.5 barrels of petroleum for each foot drilled, up from a small fraction of a barrel in 1950, and thus the time when the U.S. actually stops producing oil may not be when the wells run dry. The time may be sooner by 10-25 years, when the production of petroleum will no longer be a net process, i.e., the energy cost will be the same as the value of the energy covered (see figure).

The curves for 'barrels-per-foot-drilled' appear to be very sensitive to the rates of drilling. At high rates the yield per drilled foot is about 300% lower than at low rates. Combination of the many factors that enter into this analysis, however, could conceal the causes. For example, federal taxation policy can strongly influence the profits taken by oil discovery. Likewise, a large portion of the drilling foot-logs may not be for the search of new discoveries. Most drilling is done in known fields to extend the yield, as in oil-normie permit.

If one views the exponentials as simply as a 'number cruncher' would, one might conclude (as did Hall and Cleveland) that 'the current trend of increasing conventional effort by the oil industry may not be in the best interest of the nation' [op. cit.]. This conclusion is an obvious one, based on the trend to lower efficiency at the higher rates of drilling. Instead, one is reminded of the extraction rates of other industries in the field of natural resources. The mining and metals industry has traditionally been able to improve its extraction efficiency as concentrations of metals in ores have decreased from several percent to a few tenths of a percent. What has been apparent in the mining and other extraction industries is that the product per ton of ore increases just as it has always been that extensive lower grade ore deposits are more economic than lesser extents of more concentrated ore, the rule has been that the lower grade ores last longer, much longer. Improved extraction is the key.

As in the mining industry, the yield of barrels per foot drilled may level off, as the 'grade' of petroleum deposits decreases. If petroleum is replaced by solid fuel (coal) in industry and in power generation, not only will the petroleum cost of drilling and extracting go down (possibly to zero), but the need for new discoveries will be less desperate. Rumors of huge petroleum deposits centered in Wyoming, planned extensions of new fields off Alaska (although the last 200 wells drilled in Prudhoe Bay were dry), and discovery of new potential oil fields under the Appalachian and along the continental margins can only add to the ex-

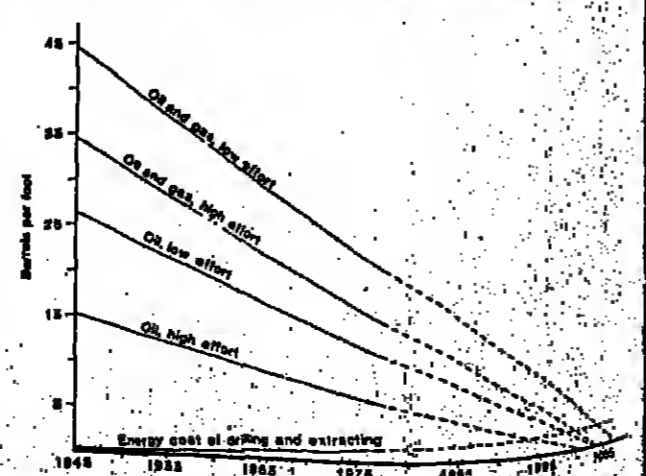


Fig. 1. Curves: Oil and gas yield in barrels per foot drilled vs. time (end exploration effort) and energy costs for drilling (after O. Hall and C. Cleveland, *Science*, 211, 578-579, 1981).

tensive but lower grade (or higher cost) fields. It appears therefore, that the leveling off of the function (now difficult to predict) that describes the demand for petroleum versus the supply is the key intangible.—PMB

### 1980 Weather Summary

The weather in the United States during 1980 was bad. A 3-month heat wave in the southwest caused about \$20 billion in ruined crops, an increase in power consumption, and damage to roads and highways. Nationwide, the heat killed 1320 people. Floods caused more than \$1 billion in losses. Hurricane Allan caused about \$500 million in property losses and took two lives.

The highest temperature reading during 1980, 51° C (124° F), was reached five times. Locusts were at Bull Head, Arizona; Death Valley, California; and three times at Baker, California. Preliminary figures also show that the lowest temperature for the year was recorded at Tok weather station, 150 miles southeast of Fairbanks, Alaska. There the mercury plummeted to -56° C (-68° F). In the lower 48 states the minimum thermometer reading was -44° C at Wladom, Montana.

Deaths caused by lightning were down to 78 last year from the 20-year average of 104. Deaths caused by tornadoes dropped to 28, the second lowest total in 85 years. Lightning storms also produced more than \$750 million in damage.

The following is a summary of the extraordinarily bad weather:

Spring flooding began in March in Alabama and Mississippi with rainfall of 18 inches, more than three times normal. Also in March, Mt. St. Helens erupted. Although not of itself a weather event, the huge plumes of ash and gases affected the weather. The eruption left 34 dead and caused more than \$150 million damage.

On April 27 heavy thunderstorms and wind gusts of up to 42 mph contributed to conditions that caused a ship to crash into Sunshine Skyline Bridge at Tampa Bay. Thirty lives were lost, and harbor traffic was delayed for 5 days.

The great summer heat wave—between June and mid-August—was the United States' most devastating weather calamity during 1980. On July 13, temperature records were shattered in several southern states. Dallas, Texas, had 38° C (100° F), or above, each day from June 23 to August 3.

The corn, cotton, peanut, and spring wheat crops were particularly hard hit by the heat. The Consumer Price Index for food and beverages, which had risen only one third as much as the rest of the index during the first half of 1980,

## New Publications

### Dynamics of the Magnetosphere

S.-I. Akasofu (Ed.), D. Reidel, Dordrecht, Massachusetts, xi + 656 pp., 1980.

Reviewed by A. Nishida

Earth's magnetosphere is a huge energy converter floating in the solar system. It absorbs energy from the solar wind in the earth's neighborhood in highly ingenious ways and creates a variety of phenomena, among which are the aurora, natural radio waves, and trapped radiation. Human understanding of the nature of this energy converter has advanced tremendously owing to the advent of spacecraft which has made the in situ observations of the key features possible, and there is a widely shared feeling in the community that the investigation of our magnetosphere will contribute to the understanding of the cosmic phenomena in general by establishing elementary characteristics of space plasmas on experimental bases.

This volume is an outcome of a 1-week symposium that was held at Los Alamos Scientific Laboratory on October 9-13, 1976, and it provides a comprehensive overview of the current state of development of the magnetospheric research. From observations and theoretical efforts in the past, one mechanism has emerged as a key process—reconnection of magnetic field lines. This mechanism has been invoked both for entry of the solar-wind energy into the magnetosphere and for sudden outbreak of particle acceleration within the magnetosphere. At the same time this mechanism has never failed to have sound criticisms, and in this sense it has played a role of a highly stimulating guiding hypothesis. We can see that the concept of reconnection is either discussed explicitly or serves as an undertone in most of the papers contained in the volume.

The volume has 32 papers, and it is divided into six chapters. Chapter 1, 'Interplanetary Magnetic Field and the Magnetosphere,' deals with entry of the solar-wind energy into the magnetosphere. The fact that the chapter on the energy supply has 'interplanetary magnetic field' within the title clearly demonstrates the status of the reconnection hypothesis in the field. Four papers review observational evidences which testify to the dependence of the magnetospheric conditions on the interplanetary magnetic field, and N. U. Crooker presents his most recent model of the topology of reconnected field lines on the dayside of the magnetosphere. A lucid theoretical account of transport mechanisms at the magnetopause is given by B. U. Ö. Sonnerup. But the dayside reconnection is not short of critics. S. Menka et al. report an analysis, based on observations of the dayside aurora, which claims that lowering in latitude of the dayside cusp cannot be taken as an unquestionable evidence of the dayside reconnection as has formerly been suggested.

Chapter 2, 'Magnetosphere-Ionosphere Coupling,' deals with the final destination of the supplied energy. Empha-

jumped twice as much during the second half.

Of the named 11 tropical storms, only one, Hurricane Allan, struck the U.S. mainland.

Autumn brought smog and heat to the Los Angeles basin from September 28 to October 11. This produced 'hazardous' pollution levels for 3 days and temperatures averaging above normal.

The year ended with floods in the Pacific Northwest, where a 2- to 5-inch rainstorm December 28-29 hit parts of Washington and Oregon. [Source: NOAA]—PMB

### Seismic Reflection Data Available

High-resolution seismic reflection data are now available for the area offshore the southeast Georgia embayment associated with Outer Continental Shelf (OCS) lease sale 58.

Approximately 6400 km of high-resolution data were gathered from 288 tracks that covered 1,625,251 million acres in water depths from 14 m to 2025 m. These data were gathered to help evaluate the geological hazards related to oil and gas development in the area.

Data were collected and interpreted by Fairfield Industries, Inc., under contract to the U.S. Geological Survey. USGS provided the data to the National Geophysical and Solar-Terrestrial Data Center for public distribution.

For additional information, contact the National Oceanic and Atmospheric Administration, EDIS/NGSDC Code D621, 325 Broadway, Boulder, Colorado 80303, or call (303) 497-6338.

### Science Policy Fellowships

To encourage scientists to contribute to public policy issues that involve the natural sciences, the Brookings Institution in Washington, D.C., has established a Science Policy Fellowship program, slated to begin with the 1981-1982 academic year. The program will bring senior scientists to Washington for 1 year to work with the Brookings staff on science policy issues.

Fellowships will be awarded annually to three scientists from among candidates nominated by an advisory committee, by departments of natural science at universities and private research institutions, and by the public sector. The new program is supported by a 3-year grant from the Sloan Foundation.

For additional information about the fellowships, contact Jim Farrell, The Brookings Institution, 1775 Massachusetts Avenue, N.W., Washington, D.C. 20036 (telephone: 202/797-6220).

On the large-scale electric current system produced three-dimensionally from the magnetosphere to the ionosphere. While the gross structure of this current system has been deduced from spacecraft observations, the ground-based radar system has played a powerful role in delineating its fine structures and temporal developments. R. A. Greenwald provides us with comprehensive information on the latter subject starting from the basic theory.

Chapter 3, 'Plasma Processes in the Magnetosphere,' contains theoretical papers only. Theoretical papers are scattered throughout other chapters, too, and cannot find a clear distinction between the papers in this chapter and the theoretical papers given elsewhere, particularly in chapter 5. Subjects discussed are plasma microinstabilities in relation to reconnection, overall dynamics and energetics of magnetospheric substorms, and magnetic pulsations associated with substorms. K. Papadopoulos presents a convenient summary of frequencies, growth rates, and excitation conditions for several modes of plasma waves which may be important in the magnetotail.

Chapter 4 is entitled 'Ring Current Formation.' The ring current that flows around the earth is carried by energetic particles trapped in the geomagnetic field, and its growth reflects injection of energy into the radiation belt. The energy is most certainly supplied by the solar wind, but the particles that constitute the radiation belt are not entirely from the solar wind. D. J. Williams reviews observational evidences, obtained from ion composition measurements, that suggest injection of the accelerated ionospheric ions into the radiation belt. It is unfortunate that complementary observations on electrons are not available in this volume. Physics of the field-aligned electric field is not discussed very extensively, either, while its importance is emphasized repeatedly.

The topics in chapter 5, 'Substorm Mechanisms,' range from a crude outline of the overall mechanism to detailed mathematical or numerical presentation of some specific mechanism. G. Atherton in the first half of his paper gives a concise and clear presentation on the basic processes that govern energy flow from the solar wind to the magnetosphere. A. Haegawa and T. Sato present a beautiful mathematical formulation of linkage between the magnetospheric current and the field-aligned current. S.-I. Akasofu advocates that the substorm is driven directly by energy supply from the solar wind rather than by unloading of the energy stored inside the magnetosphere. He also advocates a 'current interruption model' in which the interrupted cross-tail current is diverted toward the earth. Doesn't interruption of the cross-tail current mean unloading of the magnetic field energy of the tail?

Chapter 6 is entitled 'Substorm Processes in the Magnetotail,' and here reconnection in the magnetotail is the central issue. The spell of reconnection is so great that every tailward flow of plasma and every southward polarity of magnetic field appear to be compared with expectation from the re-

### Water Quality Tested in Kentucky Coalfields

The Kentucky Geological Survey received a \$1.1 million grant to collect information on groundwater quality and quantity in the eastern Kentucky coalfields. The funding extends a 1-year, \$211,000 grant from the U.S. Geological Survey.

Water will be sampled continuously from between 40 and 50 core holes or wells, each drilled to an average depth of 120 meters. Quality and level of the water are the main concern of the monitoring. By using standard submersible pumps, researchers will also be able to test each well's potential to supply water to industry and municipalities, according to Jon Kleier, project coordinator.

Impetus for the project is the Surface Mine and Reclamation Act of 1977, which requires assessments of surface water and groundwater before a mining permit is issued. In addition, water conditions that may change during or after mining must be outlined.

A final report is expected to be published in January 1985.

### Field Research Proposals

The Center for Field Research is seeking proposals from postdoctoral scholars in need of funding, and they are also seeking volunteers for field work. The center relies on volunteers from Earthwatch, a national volunteer program. These volunteers provide the finances to cover all their own field costs and a designated share of project expenses. Total annual awards from the center exceed \$800,000.

Research must be able to use teams of volunteers in the field to qualify for support. Dissertation and undergraduate research are not currently eligible; however, inclusion of graduate students as staff is encouraged. There are no limits on the geographic location of projects.


To apply, submit a two-page preliminary proposal that outlines objectives, project dates, and the need for funds and volunteers. Upon favorable review, the center will invite the applicant to prepare a formal proposal. Preliminary proposals have no deadline, but formal ones are due April 1 and October 1 and must precede the field work by 9 months.

For additional information on application procedures and a listing of projects that received support in 1980, contact Pettit A. Prunhuber, Project Manager, The Center for Field Research, 10 Juniper Road, Box 127-N, Belmont, Massachusetts 02178 (telephone: 617-489-3032).

connection model; every case which does not comply with the expectations is announced as a fatal blow to the idea. Apparently, reconnection cannot explain everything, but it is also true that the cases presented by E. W. Hones are compatible with the reconnection model but not with another proposed model (reflection wave model). It is my impression that there are multitudes of driving mechanisms for the magnetotail dynamics.

A great majority of the papers contained in this volume are well written and self-contained; the volume is free from the flow, often encountered in conference proceedings, of carrying fragmentary pieces of work. Owing to space limitations, unfortunately only a small fraction of the good papers could be cited. Where there is conflict in views, both parties are well represented. Clear theoretical articles, such as those quoted above, augment the value of the book.

THE CENTRAL NORTH ATLANTIC OCEAN BASIN AND CONTINENTAL MARGINS: GEOLOGY, GEOPHYSICS, GEOCHEMISTRY, AND RESOURCES, INCLUDING THE TRANS-ATLANTIC GEOTRAVERSE (TAG) BY PETER A. RONA, NOAA



# noaa atlas 3

THE CENTRAL NORTH ATLANTIC OCEAN BASIN AND CONTINENTAL MARGINS: GEOLOGY, GEOPHYSICS, GEOCHEMISTRY, AND RESOURCES, INCLUDING THE TRANS-ATLANTIC GEOTRAVERSE (TAG) BY PETER A. RONA, NOAA

- 22 MAPS (LATITUDE 30°N-30°N)
- BOTTOM PHOTOGRAPHIC TRAVERSE
- SEISMIC REFLECTION SECTIONS
- SEISMIC REFLECTION PROFILES
- 32 GEOTRAVERSES (MAGNETIC, GRAVITY, MAGNETIC)
- PHYSICAL AND CHEMICAL PROPERTIES OF CRUST
- EXTENSIVE REFERENCES
- BIBLIOGRAPHY

This atlas is a comprehensive, single-volume synthesis of studies, research, and environmental investigations conducted by the U.S. Geological Survey and other agencies in the Central North Atlantic Ocean Basin and Continental Margins.

—Charles E. Drake

Price: \$17.50 (hard cover) \$14.50 (soft cover) \$12.50 (paper)  
 ISBN 0-607-00000-0  
 Order from: DHEI 50  
 SUPERINTENDENT OF DOCUMENTS  
 U.S. GOVERNMENT PRINTING OFFICE  
 WASHINGTON, D.C. 20540



## EOS

TRANSACTIONS, AMERICAN GEOPHYSICAL UNION  
 The Weekly Newspaper of Geophysics

Editors: A. F. Spilhaus, Jr.; Associate Editors: Claude J. Allegre, Peter M. Boff, Kevin C. Burke, Krishna Kotsaras, Gerard Lachapelle, Christopher T. Russell, Richard A. Smith, Scott C. Solomon, Carl Kissinger, M. W. Wright, Barbara T. Shown, Editors' Assistants: Sandra R. Marks, Eos Production Staff: Patricia Genger, Margaret W. Conley, Eric Gerson, James Hebblethwaite, Dee Sung Kim, Michael Schwartz.

Officers of the Union  
 J. Tuzo Wilson, President; James A. Van Allen, President-Elect; Leslie H. Meredith, General Secretary; Carl Kissinger, Foreign Secretary; A. F. Spilhaus, Jr., Executive Director; Waldo E. Smith, Executive Director Emeritus.

Advertising that meets AGU standards is accepted. Contact Eileen O. Smalls, advertising coordinator, 202-462-6903.

*Eos*, Transactions, American Geophysical Union (ISSN 0096-3941) is published weekly by the American Geophysical Union from 2000 Florida Avenue, N.W., Washington, D.C. 20009. Subscription available on request. This issue \$5.00. Second-class postage paid at Washington, D.C., and at additional mailing offices.

Copyright 1981 by the American Geophysical Union. Material published in this issue may be photocopied by individual scientists for research or classroom use. Permission is also granted to use short quotes and figures and tables for publication in scientific books and journals. For permission for any other uses, contact AGU Publications Office, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

Views expressed in this publication are those of the authors only and do not reflect official positions of the American Geophysical Union unless expressly stated.

Cover: Four stages during an experimental simulation of meteor impact into a multilayered planetary surface. Part of a series of experiments conducted by R. Greeley and J. H. P. of Arizona State University and D. E. Gault of the University of California at San Diego (Murphy, California) at NASA Ames Vertical Gun Facility, July, 1980. The photos were taken sequentially with two Polaroid cameras mounted outside the target chamber. (Top left) Target prior to impact. Target consists of one-half inch thick surface layer of sand weakly bonded with epoxy (tensile strength of layer = 10<sup>3</sup> dynes/cm<sup>2</sup>) overlying clay-water slurry (yield strength = 50 dynes/cm<sup>2</sup>; plastic viscosity = 200 poise). Cylindrical bullet is 1.4 cm deep and has a 3.1 diameter. (Top right) 0.2 s after impact of one-quarter inch pyrex sphere fired at 1.84 km/s. The crust fractures and fragments into steep ejecta plume as initial crater bowl expands below surface. (Bottom left) Oscillating central mound begins to collapse, sending out a 3 cm high surge wave of substrate material. (Bottom right) Final morphology. Note circumferential and radial fractures.

This volume represents a landmark in the understanding of magnetospheric physics, and future advances will be measured from here.

A. Nishida is with the Institute of Space and Aeronautical Science, University of Tokyo.

## New Listings

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Gaysers and Geothermal Energy, J. S. Rinehart, Springer, New York, xvi + 223 pp., 1980, \$19.80.

## Classified

EOS often classified spaces for Positions Available, Positions Wanted, and Services, Supplies, Courses, and Announcements. There are no discounts or commissions on classified ads. Any type that is not publisher's choice is charged for at display rates. EOS is published weekly on Tuesday. Ads must be received in writing on Monday 1 week prior to the date of the issue required.

Reply to ads with box numbers should be addressed to: Box 500, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20006

**POSITIONS WANTED**  
Rates per line  
1-5 lines—\$1.00, 6-11 lines—\$0.75,  
12-26 lines—\$0.55

**POSITIONS AVAILABLE**  
Rates per line  
1-5 lines—\$2.00, 6-11 lines—\$1.60,  
12-26 lines—\$1.40

**SERVICES, SUPPLIES, COURSES, AND ANNOUNCEMENTS**  
Rates per line  
1-5 lines—\$2.50, 6-11 lines—\$1.95,  
12-26 lines—\$1.75

## POSITIONS AVAILABLE

**Exploration Geophysicist, University of Oklahoma.** The School of Geology and Geophysics at the University of Oklahoma will have an experienced exploration geophysicist to fill the Frank and Betty Schutte Professorship, and is seeking nominations and applications for the position. The person must be a distinguished scientist who has made important contributions to exploration geophysics through research. Preference will be given to a scientist whose specialty is seismic properties of earth materials and who has earned the Ph.D. The Schutte Professorship provides leadership and guidance in establishing a quality teaching and research exploration geophysics group. The University of Oklahoma has recently made a strong commitment to the earth sciences with the establishment of a College of Geosciences, to be housed in a new building. The School of Geology and Geophysics will expand from its present faculty of 16 to 26 faculty members by 1985. This will include three scientists in the exploration geophysics area, five in structural-tectonophysics-solid earth geophysics and others in stratigraphy-paleontology, geochemistry, petrology, and energy resources.

Applications are due April 30, 1981. Inquiries, recommendations, and applications should be sent to John W. McKenney, Director, School of Geology and Geophysics, University of Oklahoma, Norman, OK 73019.

The University of Oklahoma is an equal opportunity employer.

**Lunar Curatorial Laboratory Manager.** Nonprofit Services, Inc. has opened and maintained the NASA Lunar Curatorial Laboratory at the Johnson Space Center, Houston, Texas since its inception. We are now searching for a manager candidate with a Ph.D. in geology or geochemistry, experience in administering a laboratory, and a record of publication in the study of lunar samples and/or meteorite investigations. Position involves the supervision of 36 technical, scientific and clerical employees. Interested persons should send resume, including publications and references to W. B. Kurz, Manager of Personnel Services, Nonprofit Services, Inc., P.O. Box 34416, Houston, TX 77034.

NSI is an equal opportunity affirmative action employer.

**Physical Oceanographer/Geophysical Fluid Dynamist**

Arofe Associates, a growing research firm, located in Southern California, organizes theoretical and empirical physical oceanography, is offering permanent, full-time positions. Candidates require Ph.D. (or equivalent experience) in physical oceanography or geophysical fluid dynamics. Salaries are competitive and negotiable, based on qualifications. Arofe offers a fringe benefit package of superior quality. Qualified candidates should send resume, salary history, and list of professional references to:

Personnel Administrator  
Arofe Associates  
P.O. Box 350  
Encino, CA 91316

An equal opportunity employer M/F.

**Asst. Univ. Prof.** The Department of Geology, Acadia University, is seeking a highly qualified individual to fill a tenure track position in the field of geology and related fields and/or energy resources. Rank and salary will be appropriate to qualifications. The successful candidate will assume leadership of an established, vigorous and growing department with five faculty members, and over 100 B.Sc. and M.Sc. candidates. Responsibilities include teaching at undergraduate and graduate levels, and academic planning and development in the specialty.

A letter of application together with a curriculum vitae and names of three referees should be sent by March 15, 1981 to Dr. Einar E. Zuck, Dean of Science, Acadia University, Wolfville, N.S., B0P 1X0.

**Faculty Position University of Iowa.** The Department of Physics and Astronomy anticipates one or two openings for tenure track faculty in August 1981. Research specialties for which substantial resources are available are magnetospheric and solar physics and space and planetary plasma physics, both theoretical and experimental. Other specialties of interest are astrophysics, astrophysics, elementary particle physics, atomic physics, condensed matter, and low energy nuclear physics. The position involves undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a resume, a statement of research interests, and the names of three professional referees to Search Committee, Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242.

The University of Iowa is an equal opportunity affirmative action employer.

**Sediment Transport/Oceanographic Oceanography, North Carolina State University.** A tenure track position is available in the Department of Marine, Earth and Atmospheric Sciences at the level of assistant or associate professor. Applicants should have a thorough understanding of sediment transport, and a general background in geological oceanography. A Ph.D. is required. The candidate will be expected to strengthen the graduate teaching and research programs. The applicant's research interests can be theoretical, experimental, or observational, but must involve quantitative examination of sediment transport. Applicant should forward a resume, including a list of courses taken, and a list of at least three references to Dr. Charles A. Nittrouer, Chairman, Search Committee, P.O. Box 5068, NC State University, Raleigh, NC 27650. Application materials should be sent by March 31, 1981.

North Carolina State University is an equal opportunity affirmative action employer.

**Faculty Appointment/Colorado State University.** The Department of Earth Resources, Colorado State University invites applications for a tenure track appointment with emphasis on active research experience in remote sensing, and an interest in teaching graduate and undergraduate students beginning September 1981. The candidate is expected to have a Ph.D. degree in geology, earth sciences or in a related field and is expected to develop and maintain a vigorous research program with special emphasis on the application of state-of-the-art remote sensing techniques to the investigation of natural resource phenomena. The candidate is expected to teach undergraduate and graduate courses in the application of remote sensing to natural resources.

Rank and salary are open and dependent on experience and qualifications of the applicant.

Applicants are invited to submit curriculum vitae, three letters of reference and a letter describing research and teaching interests to Dr. H. S. Byrne, Department of Earth Resources, Colorado State University, Fort Collins, Colorado 80523-9033-461.

Deadline for receipt of applications is April 15, 1981.

CSU is an EOE/AA E.O. Office, 314 Student Serv. Bldg.

**Geophysicist/Department of Earth Sciences, University of California, Riverside.** Applications are invited for a (100% time) sabbatical leave replacement, as visiting lecturer in geophysics, in the Department of Earth Sciences, for the academic year 1981-1982.

A broadly-based person who has teaching interests in applied geophysics is desired. A Ph.D. is prerequisite. Salary in the \$18-19,000 range. Duties will include teaching both undergraduate and graduate courses in two or more of the following areas, depending upon the background of the applicant selected: heat flow, electrical or seismic exploration, and data processing.

A complete resume, including the names and addresses of three references, should be sent by March 23, 1981 to: Dr. T.C. Lee, Chairman, Search Committee, Department of Earth Sciences, University of California, Riverside, CA 92521, Telephone (714) 787-4508.

Equal opportunity affirmative action employer.

**Geochemistry/Brittle Deformation, University of New Brunswick.** The Department of Geology has a tenure track position available from July 1, 1981 at assistant professor or higher level. The successful applicant will be expected to teach both undergraduates and graduates as well as carrying out research and supervising graduate students.

Applications will be accepted in the following fields: geochemistry of a body, exploration, environmental or soil geochemistry, brittle deformation, rock mechanics or other engineering. Applicants should have a Ph.D. and preferably, postdoctoral experience. Applications including a curriculum vitae and names of three referees should be sent to P. F. Williams, Chairman, Department of Geology, University of New Brunswick, Fredericton, N.B. E3B 5A3.

**Battelle, Pacific Northwest Laboratories.** Applications are invited for a postdoctoral position in geophysics with emphasis on middle or upper atmosphere research at the Battelle Observatory in Richland, Washington. Stipend will be

An equal opportunity employer.

**Principles of Mineral Behaviour, Geoscience Texts, vol. 1, J. D. C. McConnell, Elsevier, New York, x + 257 pp., 1980, \$45.00 cloth, \$24.95 paper.**

**A Priori Prediction of Roundoff Error Accumulation in the Solution of a Super-Large Geodetic Normal Equation System, NOAA Prof. Rep. 12, Palar Malsisi, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, Md., x + 128 pp., 1980.**

**Radio Interferometry Techniques for Geodesy, NASA Conf. Publ. 2115, National Aeronautics and Space Administration, Washington, D.C., vii + 493 pp., 1980.**

**Scientific, Technological and Institutional Aspects of Water Resource Policy, AAAS Selec. Symp. 49, Y. Y. Halmag (Ed.), American Association for the Advancement of Science, Washington, D.C., xiv + 128 pp., 1980.**

\$18,000 initially; the position offers the possibility of a permanent research position at the end of the postdoctoral appointment. Address inquiries to R. A. Stokes, Battelle Observatory, Battelle, Pacific Northwest Laboratories, P.O. Box 993, Richland, WA 99352.

**Oceanographic Measuring Techniques.** The Marine Science Program at North Carolina State University (Raleigh) is expanding its oceanographic technical services group and is currently seeking a technician familiar with the design and deployment of deep-sea current meter mooring arrays, as well as with standard shipboard oceanographic sampling techniques.

Qualifications include a degree in science or engineering with some electronics background and two years field experience or an equivalent combination of education and experience. Salary commensurate with education and experience. Send resume and names of references to Personnel Services, North Carolina State University, P.O. Box 5087, Raleigh, NC 27650.

An equal opportunity employer.

## Vincent C. Kelley and Leon T. Silver Graduate Fellowships THE UNIVERSITY OF NEW MEXICO

The Department of Geology of the University of New Mexico invites applications for the Vincent C. Kelley and Leon T. Silver Graduate Fellowships. The fellowships will be awarded on the basis of the scholastic record and academic promise of graduate applicants. Each fellowship will provide for a generous living stipend of \$1,000/month for 9 to 12 months, and up to \$2,000/year for travel and research expenses. The Caswell Silver Foundation will pay all tuition and university fees. The awards are made on an annual basis, but may be renewed for up to three years as long as the student maintains excellent academic standing and shows evidence of significant progress in research. Preference will be given to, but is not restricted to, applicants for the Ph.D. program.

An application for admission to the UNM Graduate Program, transcripts, Graduate Record Exam results (verbal, math & geology), three letters of reference and a brief statement of research goals are required for consideration for the fellowships. Application materials may be obtained from:

Rodney C. Ewing  
Chairman  
Department of Geology  
University of New Mexico  
Albuquerque, New Mexico 87131

The deadline for applications is April 1, 1981 for the Fall semester of 1981.

## The Caswell Silver Distinguished Professorship in Geology THE UNIVERSITY OF NEW MEXICO

The Department of Geology of the University of New Mexico is pleased to invite nominations or applications for the Caswell Silver Distinguished Professorship in Geology. This endowed professorship shall be awarded for periods of up to two years to a geologist of distinguished accomplishment and international reputation. The professorship may be held by scientists of all specialties of the earth sciences in the broadest sense, and the major criterion for selection is that the individual be an active, productive leader in his or her field of research. The recipient must carry out a vigorous research program while in residence at UNM. The recipient is expected to interact with the faculty and advanced topics of higher choice, during each academic year. The Foundation will provide a unusually advantageous remuneration commensurate with the distinguished nature of the appointment. In addition, a generous allocation for travel and operating expenses (to include secretarial support, analytical services in department laboratories, use of field vehicles, and preparation of manuscript) will be provided.

Applications or nominations should include a detailed resume and brief statement of major research accomplishments. Applications or nominations should be forwarded to:

Rodney C. Ewing, Chairman  
Department of Geology  
University of New Mexico  
Albuquerque, New Mexico 87131

The Caswell Silver Foundation is an equal opportunity employer.

**Assistant Professor Planetary Sciences.** The Department of Geology at the University of Illinois, Urbana-Champaign, has an opening for a tenure track position of the assistant professor level, beginning during the 1981-82 academic year. A Ph.D. is required. The applicant should have a strong background in geology, and post-doctoral experience in planetary sciences. The successful candidate is expected to develop an active research program in complementing existing programs in geodynamics, solid earth geophysics, and rock physics. There is also opportunity for interaction with programs in the Department of Theoretical & Applied Mechanics and Civil Engineering, and the Interdisciplinary Materials Research Laboratory. Send resume and names of three references to: Dr. John Hower, Head, Department of Geology, University of Illinois, 245 Natural History Bldg., 1301 W. Green St., Urbana, IL 61801 (Telephone: 217/333-3542). Applications should be received by April 15, 1981.

The University of Illinois is an affirmative action equal opportunity employer.

**Professor Yervant Terzian**  
Chairman, Department of Astronomy  
Spec Sciences Building  
Cornell University  
Ithaca, NY 14853

Candidates should also arrange for three letters of recommendation to be sent to the above address. All correspondence and materials must be received by April 30, 1981.

Cornell University is an equal opportunity/affirmative action employer.

**Sedimentary Geologist/Micropaleontologist, Washington University.** The Department of Earth and Planetary Sciences, Washington University, has available a tenure track, assistant professor position, beginning in the 1981-82 academic year for a geoscientist with research interests in geology of sediments or in micropaleontology.

The successful candidate must have the following attributes: demonstrated creativity and promise of excellence in research and teaching; intent to develop a vigorous graduate research program; desire to teach courses in field of interest and related fields of geoscience at undergraduate and graduate levels.

Send resume, statement of future research interests, and names of at least three references, to Larry Haskin, Chairman, Department of Earth & Planetary Sciences, Washington University, St. Louis, MO 63130. Applications received through April 15, 1981.

Washington University is an equal opportunity/affirmative action employer.

**Faculty Position in Physical Oceanography.** The Department of Marine, Earth and Atmospheric Sciences at North Carolina State University invites applications for a nine-month, part-time, tenure track position at the assistant or associate professor level for a physical oceanographer, specializing in the numerical modeling of oceanic flows.

Applicants should have a strong background in geophysical fluid mechanics and the abilities to develop a funded research program and graduate level courses in physical oceanography. Rank open. Send resume, three references and statement of research interest and plans to: Dr. A. J. Budding, Chairman Search Committee, Geoscience Department, New Mexico Institute of Mining & Technology, Socorro, NM 87801. Closing date March 31, 1981.

Send curriculum vitae and the names of three references by March 31, 1981 to Professor G. S. Jancovics, Chairman, Search Committee in Physical Oceanography, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, P.O. Box 5059, Raleigh, NC 27650.

North Carolina State University is an equal opportunity/affirmative action employer.

**Solid Planet Geophysicist/Texas A&M University.** The Department of Geophysics at Texas A&M University is pleased to announce availability of a junior level, tenure track faculty position. The department emphasizes solid earth geophysics with concentrations in tectonophysics, geodynamics and internal structure. We are seeking a talented and active researcher and teacher who will complement existing faculty and broaden current areas of expertise. There are excellent opportunities for interaction and collaboration with members of our department as well as those in the departments of oceanography and geology and in the center for tectonophysics. Qualified scientists are requested to send resume to Neville L. Carter, Head, Department of Geophysics, Texas A&M University, College Station, TX 77843.

Texas A&M University is an equal opportunity employer.

**Chemical Oceanographer.** Research associate, M.S., marine organic geochemistry and its relation to ocean productivity. Cooperative Institute of Marine and Atmospheric Sciences, University of Miami and National Oceanic and Atmospheric Administration, contact Chairman Search Committee, D. K. Atwood, NOAA/AOML, 15 Rickenbacker Causeway, Miami, FL 33149.

**Arth Johnston, Director**  
Tennessee Seismological Information Center  
Memphis State University  
Memphis, Tennessee 38152

Memphis State University is an equal opportunity/affirmative action employer.

**Seismologist.** The Tennessee Earthquake Information Center (TEIC) is seeking applications for the position of seismologist beginning July 1981.

The position will also be an excellent opportunity in the Department of Geology. Primary duties, however, are with TEIC; teaching will be on a time-available basis, not to exceed one course per semester.

The Ph.D. is required and experience with telemetry networks is highly desirable. The successful applicant will be expected to assume co-responsibilities on the Memphis and Southern Appalachian seismic networks, as well as actively pursue externally funded research projects digital data processing, seismic hazard assessment and public information are other aspects of the job.

The TEIC is a research organization of Memphis State University and the State of Tennessee, 12-month salary (\$25,000 and above) depends on qualifications and experience. Position is 1/2 state supported, 1/2 (summer) from external sources.

Application deadline: 15 April 1981. Send resume, publications list, short statement of research interests, and names and addresses of four referees to:

Arth Johnston, Director  
Tennessee Seismological Information Center  
Memphis State University  
Memphis, Tennessee 38152

Memphis State University is an equal opportunity/affirmative action employer.

**Geophysical Monograph 21**

Order Number GM2100

List Price \$23.00

20% discount to AGU members

•550 pages•

Quantitative Modeling of Magnetospheric Processes

edited by W.P. Olson (1979)

Providing an annotated list of quantitative models which serve as reference on energy particle distribution and magnetic and electric fields, this monograph was written in conjunction with the International Magnetospheric Study activities.

Published by:  
American Geophysical Union  
2000 Florida Avenue, N.W.  
Washington, D.C. 20009

Orders under \$30.00 must be prepaid

**Assistant Professor Planetary Sciences.** The Department of Geology at the University of Illinois, Urbana-Champaign, has an opening for a tenure track position of the assistant professor level, beginning during the 1981-82 academic year. A Ph.D. is required. The applicant should have a strong background in geology, and post-doctoral experience in planetary sciences. The successful candidate is expected to develop an active research program in complementing existing programs in geodynamics, solid earth geophysics, and rock physics. There is also opportunity for interaction with programs in the Department of Theoretical & Applied Mechanics and Civil Engineering, and the Interdisciplinary Materials Research Laboratory. Send resume and names of three references to: Dr. John Hower, Head, Department of Geology, University of Illinois, 245 Natural History Bldg., 1301 W. Green St., Urbana, IL 61801 (Telephone: 217/333-3542). Applications should be received by April 15, 1981.

The University of Illinois is an affirmative action equal opportunity employer.

**Head, Earth Resources Branch, NASA/Goddard Space Flight Center.** GS-1330-1415. \$37,071-\$50,112 per annum, full-time permanent. The Earth Survey Applications Division, Applications Directorate, NASA/Goddard Space Flight Center invites applications for the open position of Head, Earth Resources Branch. The incumbent of this position is responsible for planning, managing, and conducting broad programs in earth resources remote sensing and applied research and data analysis, emphasizing the development and demonstration of applications at remote sensing of earth resources from earth orbiting satellites. The primary areas of research in the branch are land use management, vegetation science including agricultural/forestry/irrigation and environmental monitoring/evaluation remotely sensed data and advanced techniques. Also, significant effort is dedicated to sensor data evaluation in terms of applications and scientific utility, and to specification of data acquisition and information extraction systems which best meet user scientific and resource management needs. An advanced degree in earth or physical sciences is required with education in the vegetation sciences, land use or environmental monitoring being specifically preferred. Candidates should also have several years of progressively more responsible experience in the conduct, guidance and management of remote sensing research programs and clear evidence of a strong research background indicating senior research scientist status.

Resumes (SF 17) should be sent to:  
Dr. Robert O. Price, Assistant Chief  
Earth Survey Applications Division  
Code 920  
Goddard Space Flight Center  
Greenbelt, MD 20771

Deadline for applications is April 30, 1981

**Upper Ocean Modeler.** Two postdoctoral positions in upper-ocean modeling available in the mesoscale eddy interaction group at the Florida State University, Ph.D.'s with background in fluid dynamics, theoretical physical oceanography, dynamic meteorology, numerical analysis, or physics are invited to apply. Salary range \$16,000-\$21,500/year. Positions are supported by Office of Naval Research and may be filled at any time after April 1, 1981. Send vitae and names of three references to Professor James O'Brien, The Florida State University, Tallahassee, FL 32306.

The University is an equal opportunity employer.

**Economic Geologist.** The Department of Geoscience at the University of Illinois, Urbana-Champaign, has an opening for a tenure track position of the assistant professor level, beginning during the 1981-82 academic year. A Ph.D. is required. The applicant should have a strong background in geology, and post-doctoral experience in planetary sciences. The successful candidate is expected to develop an active research program in complementing existing programs in geodynamics, solid earth geophysics, and rock physics. There is also opportunity for interaction with programs in the Department of Theoretical & Applied Mechanics and Civil Engineering, and the Interdisciplinary Materials Research Laboratory. Send resume and names of three references to: Dr. John Hower, Head, Department of Geology, University of Illinois, 245 Natural History Bldg., 1301 W. Green St., Urbana, IL 61801 (Telephone: 217/333-3542). Applications should be received by April 15, 1981.

The University of Illinois is an affirmative action equal opportunity employer.

**Assistant Professor of Mining.** Applied geophysics program to begin July 1, 1981. Applicants should have a doctoral degree, precise experience in publications, ability to supervise graduate students is essential. Salary commensurate with qualifications and experience. Send resume and names and addresses of three references by April 1, 1981 to Prof. John T. Xue, 829 S.W. Mudd Bldg., Henry Krumb School of Mines, Columbia University, New York, NY 10027.

Columbia University is an equal opportunity/affirmative action employer.

**Physical Oceanographer.** The Department of Marine Science and Engineering, North Carolina State University, has an immediate opening for a postdoctoral research associate. Research will be directed toward equatorial circulation dynamics, including seasonal and higher frequency variability. Participation in fieldwork will be required. Qualifications include a Ph.D. or equivalent in physical oceanography or geophysical fluid dynamics and experience in the analysis of oceanographic time series.

The initial appointment will be for 2 years, with a possible continuation subject to availability of funds. Salary is competitive and negotiable, based upon qualifications. Applicants should send the names of three references, a resume, and publication list to Robert H. Weisberg, Department of Marine Science and Engineering, P.O. Box 5023, NC State University, Raleigh, NC 27650.

North Carolina State University is an equal opportunity/affirmative action employer.

**Research Assistant/Utah State University.** Existing opportunities at the frontiers of knowledge exist for graduate and undergraduate research assistants in the Department of Electrical Engineering at Utah State University, USA, located at the base of the Wasatch Mountains, in engaged in ground-breaking investigations in many critical fields. Get involved in environmental sensing, digital electronics, microprocessor applications, electro-optics, or computer engineering. Do space and atmospheric physics with state-of-the-art instrumentation on the ground, in rockets, or aboard the space shuttle. For details on these and other projects, contact Doran J. Baker, Head, Department of Electrical Engineering, UMC 41E, Utah State University, Logan, UT 84332 (telephone: 801/750-2840). USU provides opportunities based only on performance.

Utah State University is an equal opportunity/affirmative action employer.

**Geophysicist.** The Geology Department at the University of Southwestern Louisiana is seeking an applicant for an anticipated research/teaching position in geophysics. Responsibilities will include one-half time in seismic investigation of geopressured-geothermal resources of South Louisiana and one-half time teaching geophysics and supervising graduate students. The successful applicant will be a research geophysicist with a Ph.D. or M.S. degree in geophysics. Salary is \$23,000 to \$35,000 per 12 months.

The position is expected to be filled in the Spring of 1981 or as soon as possible thereafter.

To apply please send a resume, three letters of recommendation, and any other pertinent materials to: Dr. Gary L. Kinloch, Geology Department, University of Southwestern Louisiana, Lafayette, LA 70504.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume in confidence to Research and Data Systems, Inc., 5400 Arapahoe Road, Lenham, MD 20801. Telephone: (301) 459-0001.

Research and Data Systems, Inc./Solaris.

Immediate opening for long-term with B.S. in science or math and at least two years experience with FORTRAN or PL/I on IBM systems. Work involves data processing and analysis from satellite based remote sensing systems. Experience with time sharing systems preferred. Also have openings for staff scientists with strong programming background. Send resume

